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R&D

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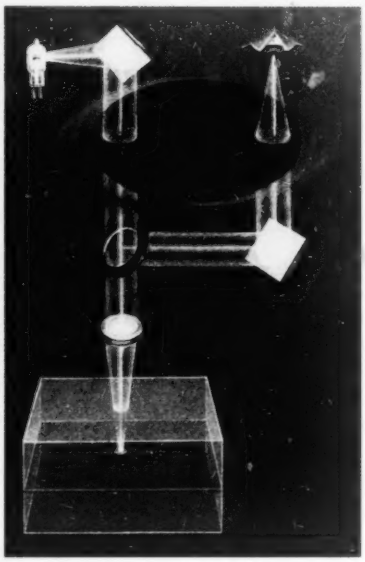

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R&D

The International Magazine of Research and Development

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ABOUT THE COVER Confocal microscopes let users analyze samples in three dimensions. See story page 40. *Photo: Technical Instrument Co.*

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Combining ESCA With SSIMS 65

SSIMS and ESCA enhance each other's ability to solve problems.

Struggling With Low Demand, Computer Firms Become More Competitive

Many U.S. computer firms are being restructured following last year's modest 8.4% production increase, the smallest annual increase since 1975. However, Japanese computer firms are increasing their capabilities for both hardware and software products.

One way Japanese firms are attempting to offset lower demand is by expanding into European markets, traditionally a U.S. stronghold. To establish a foothold in 1990, Mitsubishi Electric purchased Apricot Computers, a UK PC manufacturer, and Fujitsu bought Britain's International Computers firm. Several Japanese firms have announced plans to market new laptop products in Europe, their current market share leader.

Longer-term capabilities are being established by increasing technical prowess. Fujitsu recently announced plans for building a 400,000-m^2 R&D complex for communication, semiconductor, and computer products, and another center for software development, both in Chiba, Japan, according to a report by Nihon Keizai Shimbun, a Japanese publishing firm.

IBM will more than double its Japanese systems integration subsidiary this year, reflecting its increasing development of hardware and software.

"IBM is looking very carefully at its expenses, but we are sustaining our R&D investment," says Marc Brodsky, director of the technical staff at IBM's Research Center, Yorktown Heights, NY. "It's hard to compare IBM's investment to that of Japanese firms because they have so many subsidiaries."

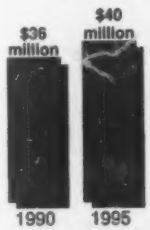
Software is another area where Japanese firms are expected to increase their penetration, according to Michael Cusumano, author of the *Japanese Software Factories.*

Fujitsu, NEC, Hitachi, and Toshiba all have established "factories" with thousands of programmers writing software for consumer and industrial products.

"I don't feel that the factory model is the most efficient way to create software," says Brodsky. "We have had examples of improved software productivity and quality by concentrating on the methodology involved in its creation."

The short-term outlook for computer firms is not bright, with only a 6.9% increase forecast for 1991, according to Cahners Economics, Newton, MA. Cahners economists forecast that demand will rebound in 1992 with a 15.2% increase. —*Tim Studt*

High Costs Limit Growth for ESCA

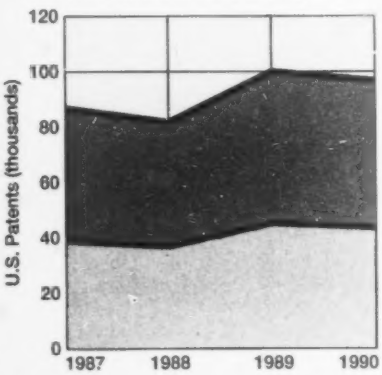


Worldwide demand for electron spectroscopy for chemical analysis (ESCA) instruments is forecast to grow about 2% annually to $40 million in 1995, according to Strategic Directions Intl., a Los Angeles-based management consulting firm.

The slow growth is caused by ESCA's high initial cost and low replacement rate. ESCA is used for surface analysis applications, such as in the detection of material impurities.

U.S. Patent Distribution Levels Off As Foreign Inventors Lose Small Share

Foreign Share of U.S. Patents Levels Off



Source: MicroPatent

Foreigners Garner Top Patents

Mitsubishi	1,385
Hitachi	1,104
Fuji	1,089
Toshiba	1,010
Canon	927
General Electric	854
Eastman Kodak	735
U.S. Philips	669
IBM	653
Siemens	604

Source: MicroPatent

***The foreign share** of the 99,275 U.S. patents issued in 1990 has leveled off in the past two years, after increasing steadily over the past several decades.*

In 1990, for the second year in a row, U.S. inventors increased their share in the total number of U.S. patents received, according to a recent survey by MicroPatent, a New Haven, CT-based publisher of patent information.

Granted, the share increase was less than 0.1%, but until 1989, U.S. inventors had decreased their patent share every year since 1977. The 99,275 patents issued in calendar-1990 is down from 102,713 issued in 1989.

About 53.4%, or 53,046, of the patents awarded in 1990 went to U.S. citizens, while 46.6% went to inventors in foreign countries. In 1990, Japan continued to increase its share of U.S. patents, rising to about 21.6% from 21.1% in 1989.

Mitsubishi, the large Tokyo-based industrial conglomerate, received the most patents with 1,385. The U.S. state with the largest number of awards was California with 7,945.

For more information, call 203/786-5500. **R&D**

Solid-State Lasers Generate Even More Applications

Increases in efficiency and power have led to solid-state lasers being used in medical and material processing areas.

By ***Tim Studt****, Senior Editor,* R&D Magazine

R&D

Lasers have become ubiquitous, involving all aspects of technology. The numbers of applications and laser products are both so great that it no longer is clear which technology drives the development of the other.

While there is continued strong demand for some of the older technology systems, such as dye- and gas-driven lasers, the major research emphasis now is on developing higher efficiency and higher power solid-state systems.

The high power, broad tunability, and solid-state convenience of titanium-sapphire lasers, for example, continue to attract researchers. Ti-sapphire lasers have been even more successful than many manufacturers expected.

"Many scientists bought Ti-sapphire lasers for their IR and near-IR wavelengths," says Mark Sobey, a product manager for Spectra-Physics, Mountain View, CA. "They hadn't used these wavelengths before, because of issues associated with IR dye lasers."

The recent availability of modelocked Ti-sapphire lasers has created even more interest. Modelocking is the locking together of the longitudinal modes of a laser, so it can oscillate in-phase on all of the modes. Modelocked pulses are very short, but have high peak power levels.

Modelocking of Ti-sapphire lasers has been obtained in a passive technique by inserting an optical element in the laser cavity, according to Colin Seaton, solid-state product manager at Coherent Inc., Palo Alto, CA.

Active or regenerative modelocking also has been obtained by tapping a signal off the laser cavity with a photodiode and feeding the photodiode's output back into the drive frequency of the Ti-sapphire laser.

"This allows the modelocker and the cavity to always stay on resonance, regardless of cavity length changes or frequency changes," says Mark Sobey, product manager at Spectra-Physics, Mountain View, CA.

Currently available products can supply more than 1 W of power in 2 psec transform-limited pulses. Prototype systems have been demonstrated with pulses that are less than 100 fsec long.

"With standard wavelength optics, you also should be able to obtain short pulses at wavelengths of about 1,000 nm," says Sobey.

The short pulses of modelocked Ti-sapphire lasers are perfectly matched for applications involving response times on GaAs semiconductors, which have bandgaps in the 800- to 900-nm range.

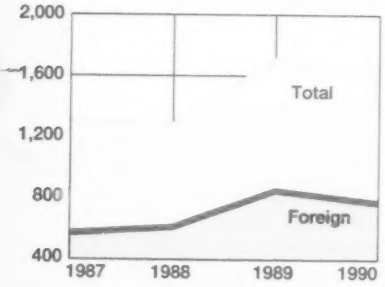
"The high powers in the IR also allow you to frequency double efficiently to about 350 to 500 nm with an output of 300 to 400 mW," says Sobey.

This is important because the energy contained in each photon of light in the blue or UV range is higher than in the red or orange ranges, thereby enabling chemists to obtain higher sensitivities in many biochemical spectroscopic applications.

"Diode arrays will be widely used for pumping solid-state lasers," forecasts James Davis, associate director for laser R&D at Lawrence Livermore (CA) National Laboratory (LLNL).

AlGaAs semiconductor diode arrays are used to pump high-power, solid-state lasers (see accompanying photo). Devices with peak powers of 1.5 kW and an average power of nearly 1 kW emitting from an aperture of about 4 cm^2 already have been fabricated.

U.S. Laser Patents

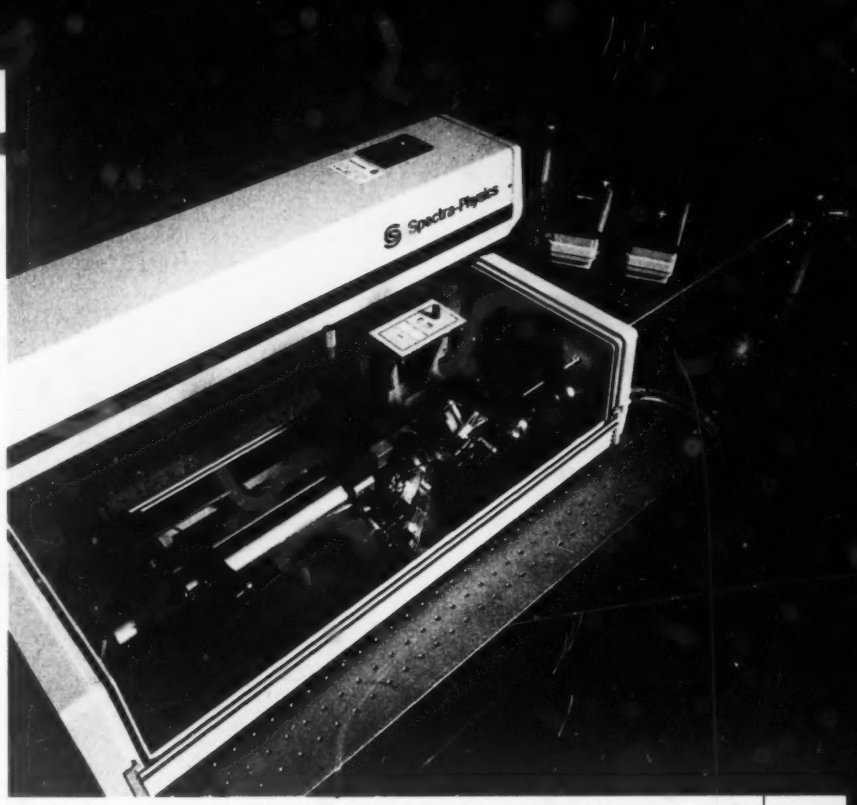


Organizations With the Most U.S. Patents

U.S. Government	70
Spectra-Physics	38
Mitsubishi Denki	38
Hitachi	35
AT&T	34
Hughes Aircraft	30
Canon	30
Ricoh	30
Eastman Kodak	28
Sharp	27

Source: MicroPatent

Foreign companies *account for almost half of all the U.S. laser patents issued every year, with five Japanese firms in the top 10 receiving the most patents.*



***Modelocked titanium-sapphire lasers** can be tuned from 720 to 840 nm and supply more than 1 W average power with transform-limited pulses less than 2 psec in length.*

Diode arrays can be used to pump solid-state lasers for cutting, welding, drilling, and weapon development, according to Davis. "There even are concepts for diode pumped lasers for a fusion power system," he says.

At the other end of the power scale, researchers at IBM's Zurich (Switzerland) Research Laboratory recently announced a development in extremely small AlGaAs semiconductor diode lasers. The IBM researchers were able to repeatedly fabricate 20,000 of these lasers on a 2-in.-dia semiconductor wafer. These devices can be integrated with other electronic components on optoelectronic chips, thereby using both light and electric current to carry information.

LLNL researchers also recently developed two new chromium-doped materials for laser media—$LiCaAlF_6$ and $LiSrAlF_6$. "These materials are similar to what you get with Ti-sapphire materials: very broad bandwidths and tunability in the near-IR," says Davis.

But these materials have better thermal characteristics than Ti-sapphire crystals, indicating they might have use in high-power applications.

There also is additional development in upconversion lasers, or solid-state lasers that emit in the visible region without the need for harmonic converters or doubling crystals.

"We're pushing toward upconversion lasers that operate at room temperature, since most of the current products operate at liquid nitrogen temperatures, such as the blue upconversion thulium system we developed last year," says Dennis Gill, deputy division leader of the Chemical and Laser Sciences Div. at Los Alamos (NM) National Laboratory.

We currently have developed an upconversion laser with two different diode pump frequencies that, depending upon the combination of the pump lights, allows you to get three different colors of light out of the laser, or combinations of those three," says Gill.

The recent explosion in applications of lasers has provided the impetus for continued development of these new systems.

Nowhere else is this as much in evidence as in the medical surgery area.

"Laparoscopic cholecystectomy, or laser-based removal of the gall bladder without the need to open the abdominal wall, has swept the medical industry in the past year," says Irving "Skip" Arons, a medical laser consultant at Arthur D. Little Co., Cambridge, MA.

This surgery is performed by inserting surgical instruments and a small video camera (laparoscope) through four puncture sites. The internal cutting, coagulating, and evaporating of the gall bladder generally is performed with laser light transmitted through a disposable fiber delivery system from a Nd:YAG source.

The advantages of medical lasers have been talked about for many years, but the lack of a significantly large number of successful procedures has limited acceptance by both patient and surgeon.

"The one technique that might have taken off was laser angioplasty to remove coronary inclusions," says Arons. "But it didn't happen because the laser's results were not any better than those using balloons."

The timing and technology for laproscopic cholecystectomy were better. In this procedure, the laser reduces the cost of the operation by half and takes a third less time to perform. But the big advantage is the reduced trauma that the patient incurs. Patients now can return to work in three to seven days, compared to the four

***Peter Lee (left), a GM researcher,** and Brad Hare of Laser Photonics developed this diode laser spectrometer to study air pollutants, but also use it as a breath analysis instrument to study diabetes.*

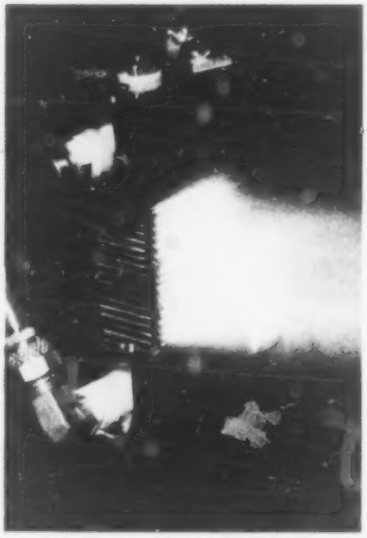
'Diode lasers will be widely used to pump hig[illegible]ower, solid-state lasers,' forecasts Livermore's Davis.

to six weeks that a conventional surgical procedure required.

About 10% of the more than 500,000 cholecystectomies in 1990 were performed with a laser. A report by Samuel Navarro, a financial analyst with Needam & Co., New York, forecasts that ratio will rise to 80% by 1995. The market for laser delivery systems for these procedures is predicted to increase from $30 million in 1990 to more than $140 million by 1995, says Navarro.

Other surgical procedures where lasers provide clear-cut clinical benefits include appendectomies, hernia repairs, bowel resections, vagotomies, abdominal hysterectomies, prostatectomies, arthroscopic surgery, angioplasty (with new wavelength lasers), dentistry, and corneal sculpting.

Corneal sculpting is expected to receive U.S. Food & Drug Administration approval by 1994, says Arons. Phoenix Laser Systems, San Francisco, recently received FDA approval for a frequency-doubled Nd:YAG surgical workstation used to correct post-cataract complications.



***This AlGaAs semiconductor** diode array has a peak power of 1.5 kW and an average power of nearly 1 kW emitting from a 4 cm^2 aperture, enabling it to pump high-power, solid-state lasers.*

This system uses a computer imaging, tracking, and stabilization system to preprogram a pattern of laser pulses where the surgeon wants to cut or remove ocular tissue. The cataract procedure is one of 11 standardized ophthalmic surgery procedures that Phoenix expects to have qualified over the next several years.

Laser processing of materials also has progressed beyond the traditional cutting and welding applications to more advanced surface processing techniques. These techniques include surface heating, melting, vaporizing, vapor deposition, and brazing.

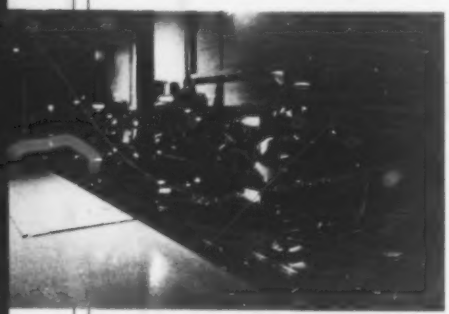
Researchers at Northwestern University's Basic Industry Research Laboratory, Evanston, IL, for example, use a laser to seal pores in a plasma-deposited Al_2O_3 coating and homogenize the surface microstructure. This surface glazing improves the wear, erosion, and corrosion resistance of a material's surface.

Integration and automation of these surface treatment processes will allow users to optimize surface coatings for specific applications. **R&D**

Big Research Bucks for Big Research Lasers

Federal agencies are forecast to increase their research spending on laser systems by more than 17% annually over the next four years, to $2.2 billion in 1995, according to Foresight Science & Technology, a market research firm in Port Townsend, WA.

About 65% of this funding will be spent on defense items, such as IR detectors and fly-by-wire avionics.



***Green-yellow light** from copper-vapor lasers is used to pump dye lasers which produce tunable, high-power light for enriching uranium fuel.*

The atomic vapor laser isotope separation (AVLIS) and inertial confinement fusion (ICF) programs at Lawrence Livermore (CA) National Laboratory (LLNL) together account for nearly $200 million in the FY91 Federal budget.

Despite other recent budget cutting announcements, AVLIS, a uranium-enrichment process, is on schedule for a late-1992, full-scale demonstration, according to Ron Cochran, deputy associate director for lasers at LLNL. Results of this demonstration will determine the status of full-production facilities.

"From the long-term standpoint, however, the U.S. Department of Energy would like a private company to handle AVLIS," says Cochran.

The ICF program involves upgrading LLNL's 100-kJ Nova laser to roughly 2 MJ at a cost of up to $400 million, spread out over the next five to 10 years. Most commercial spinoffs from the upgrade will be in better laser components, such as beam splitters, polarizers, optical coatings, and high-power switches.

Laser Companies

For more information on laser systems and components, circle the appropriate numbers on the Reader Service Card.

Space limitations preclude listing all manufacturers of this equipment. For further information, see the *R&D Magazine* Product Source under "Lasers."

Ti-sapphire	
Coherent	**618**
Excel	**619**
Lexel	**620**
Schwartz Electro-Optics	**621**
Spectra-Physics	**622**
Medical	
Candela	**623**
Laser Photonics	**624**
Laserscope	**625**
Surgical Laser Technologies	**626**

READER RESPONSE PANEL

Please rate your interest in this article by circling the appropriate number on the Reader Service Card.

High **492** Medium **493** Low **494**

Say 'No' to PC Hackers

PC users who have tied into large area networks (rather than local area networks) face the loss of confidential data to hackers. This can be prevented with the Intra-Lock security program, which requires that an encoded key and a special password be used in combination.
MIU Automation Inc. **Circle 448**

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Labtronics Inc. **Circle 442**

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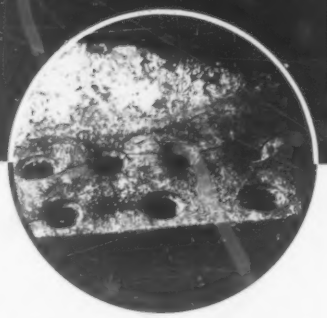

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